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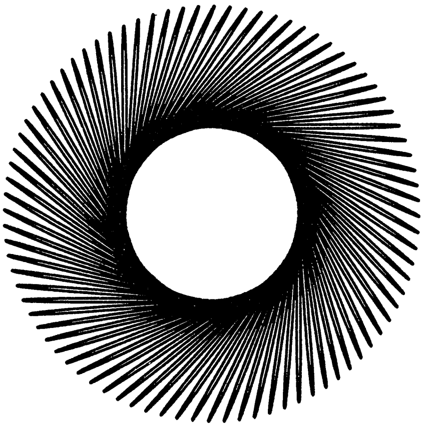
number of convolutions of the curve are uninterestingly numerous in proportion.

As α determines only the position of a curve, and this is generally of no consequence, the most convenient value of α to use is 90° when $\sin \alpha$ is a maximum and the pen is at one extremity of its harmonic path. Then when n is large and β small, the starting point is practically on the X axis. Thus Figs. 18, 19, 20 show the ratio $n = 12$ and $\beta = 0°, 3°, 19°$, respectively. In Figs. 21, 22, 23, $n = 24/5$ and $\beta = 0°, 1° 4', 5° 42'$, and in Figs. 24 and 25 $n = 84$, $\beta = 0° 38'$ and $\pm 0° 38'$. This ratio of $n = 84$ is the largest the author's machine is at present able to produce. The machine was described in the *Scientific American Supplement* of February 9 and 16, 1918. Fig. 25 is in a sense merely the double of Fig. 24. It was drawn by first tracing Fig. 24 with the B point to the right of the center, and then by starting the pen an equal distance to the left. The cuspidal nature of some of the rosettes presented is not conspicuous, especially when β is very small, on account of the closeness and apparent superpositions of the paths of the pen when near the cusp. While other and more beautiful rosettes could have been drawn, had the restriction as to cusps been waived, they would have been foreign to the present study.



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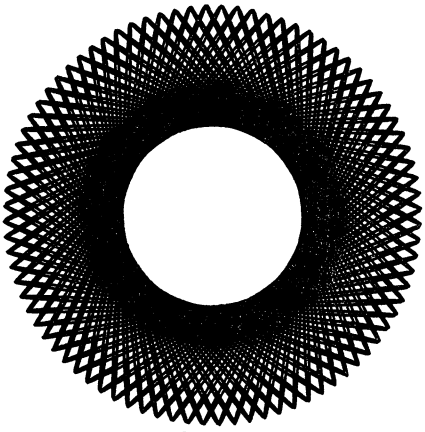

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QUESTIONS AND DISCUSSIONS.

EDITED BY W. A. HURWITZ, Cornell University, Ithaca, N. Y.

DISCUSSIONS.

What are the essential ideas which should be retained permanently by a student of the calculus, after the details and the special problems have faded from his mind? That the calculus makes a valuable contribution to the general culture of a student who has no need to make practical use of it, will not be questioned by any of us who teach it. Too often, however, we fall into a contented routine of meeting our classes with self-satisfied assurance, assigning the regular lists of problems, conscientiously explaining to the students how to surmount their difficulties with Problem 7 or Formula 42, and leaving our teaching dead with lack of emphasis and discrimination. Not seldom we fail to point out the beauties of the forest because we ourselves see only the trees. To bring us back to fundamentals such an article as Professor Rietz's discussion below must be welcomed by every earnest minded teacher of the subject.

The second discussion, by Professor Bennett, points out the disadvantages attendant on each of the usual conventions for attaching an algebraic sign to the distance between two points or between a point and a line, in analytic geometry. He concludes that the plan most commonly found in our text-books (which he calls the transcendental determination) presents more serious difficulties than either of the others. We are glad to endorse his request for "a reply in defense of the accepted methods."

As the last discussion, we present an interesting little study by Mr. B. H. Brown on a subject which has probably not hitherto received so detailed a mathematical treatment. The close agreement between theory and practice in the probabilities of various occurrences connected with "crap-shooting" is surprising. Some of the questions discussed may furnish suitable material for class problems, as for example the verification of the figures in the columns marked "Theoretical" at the beginning of the article. Devotees of the game will scarcely find in the article arguments to support its availability as a rapid road to riches.

I. On the Teaching of the First Course in Calculus.[1]

By H. L. Rietz, University of Iowa.

In his presidential address[2] read before the American Mathematical Society, Osgood expressed the view that "the calculus is the greatest aid we have to the appreciation of physical truth in the broadest sense of the word." This fact should serve to keep before teachers of the first course in calculus the following important question: Can we teach this course so that our students will feel more keenly than at present the use of the calculus in the appreciation of physical truth?

One needs only compare the text-books in calculus at present with those in use thirty years ago to be convinced that much progress has been made along this line. The first course in calculus has been enriched through a broad range of problems from everyday experience and from physical science. Moreover, logical flaws centering around the conceptions of the infinitesimal and differential have been so largely removed that the mental satisfaction derived from a close contact with physical problems has been much increased. This

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[1] Read before the Iowa Section of the Mathematical Association of America, April 26, 1919.

[2] *Bulletin of the American Mathematical Society*, Vol. 13, p. 449.